Beyond GHz: Towards a Better User Experience

Justin Rattner
Intel Fellow and Director
Intel Microprocessor Research Labs

October 15, 2001



The Change is Underway

WAS

MHz
Price



IS

Ghz
Price
Power Consumption
Reliability
Style
Ease of Use
Integrity
Communication

Total Computing Experience

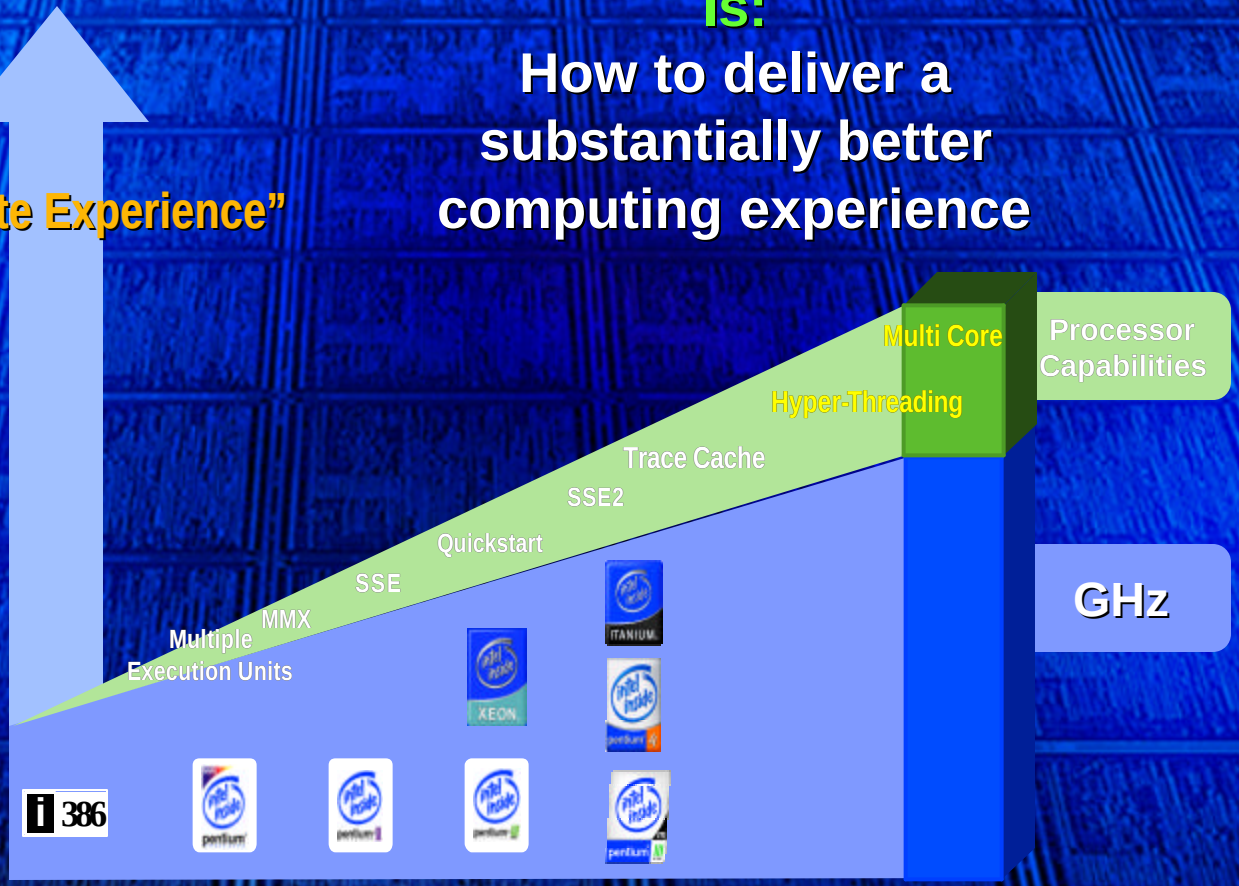


intel

GHz: Necessary, but Not Sufficient…

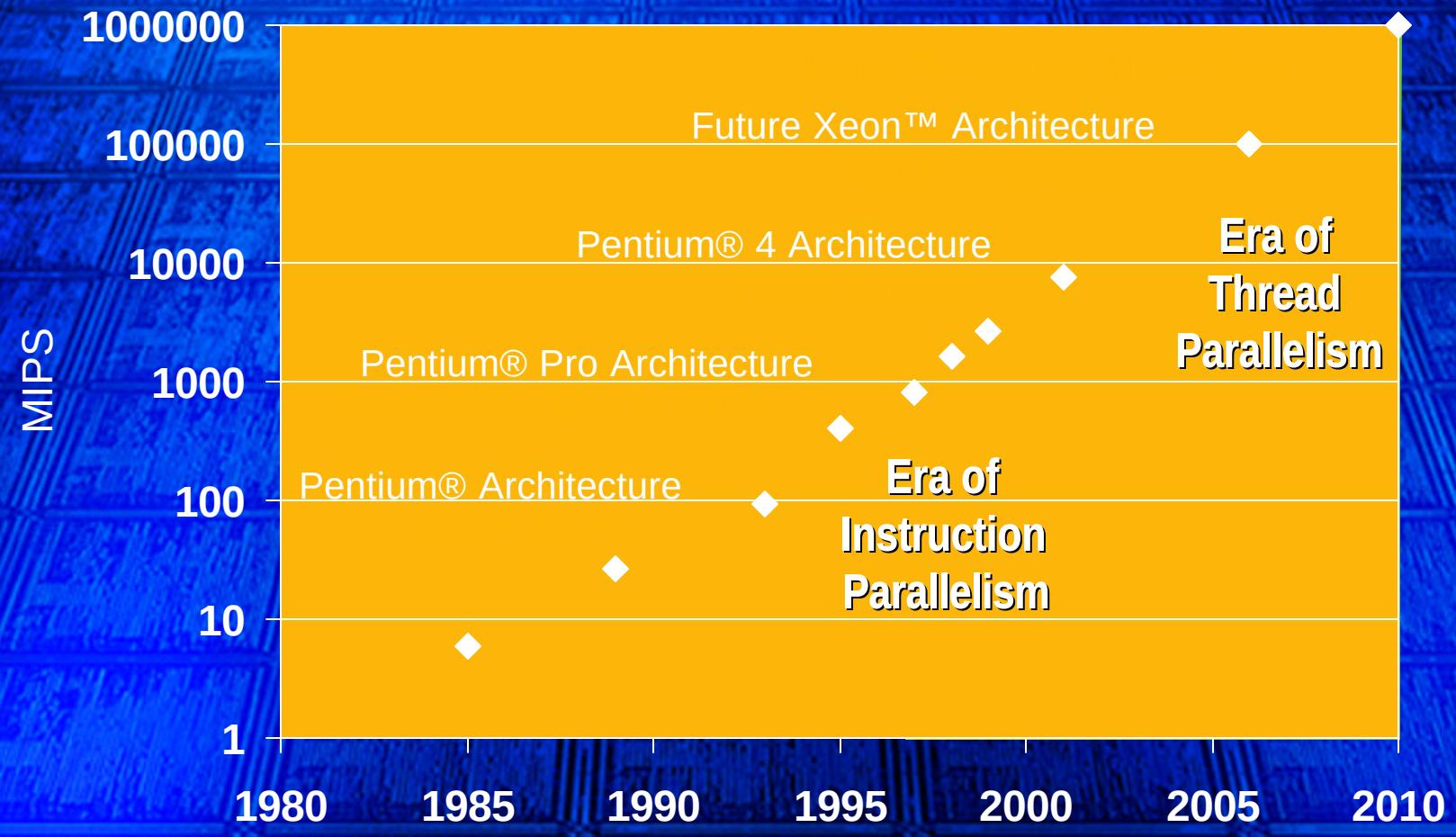
Was:
How to deliver more MHz and more MIPS

Is:
How to deliver a substantially better computing experience



intel

Microarchitecture in Transition

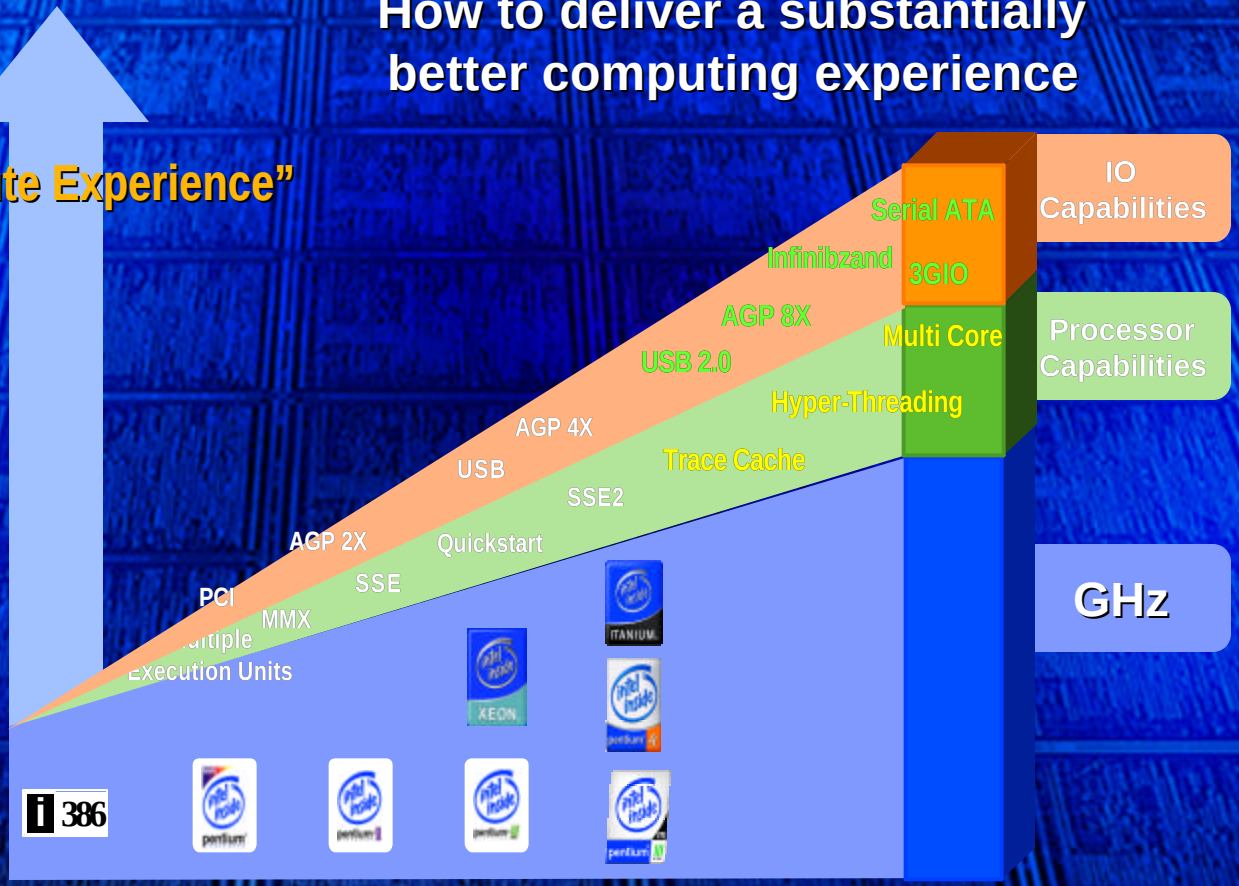


intel

Gbps: Necessary, but Not Sufficient…

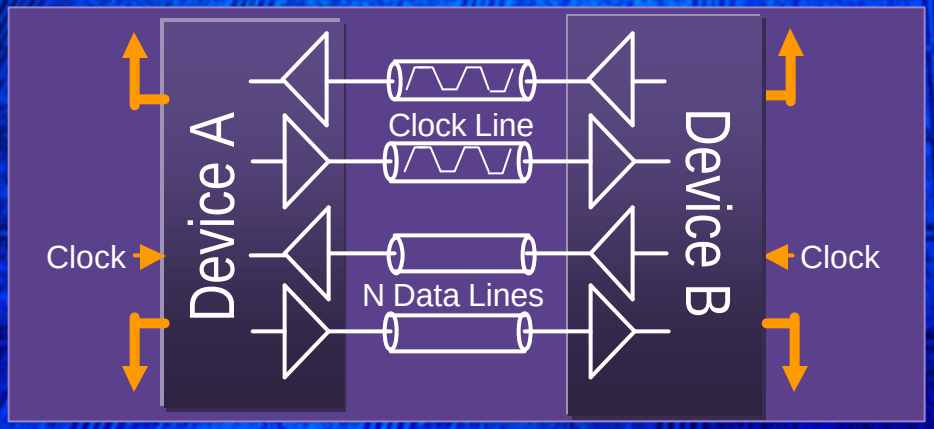
Was:
How to deliver more Gbps

Is:
How to deliver a substantially better computing experience



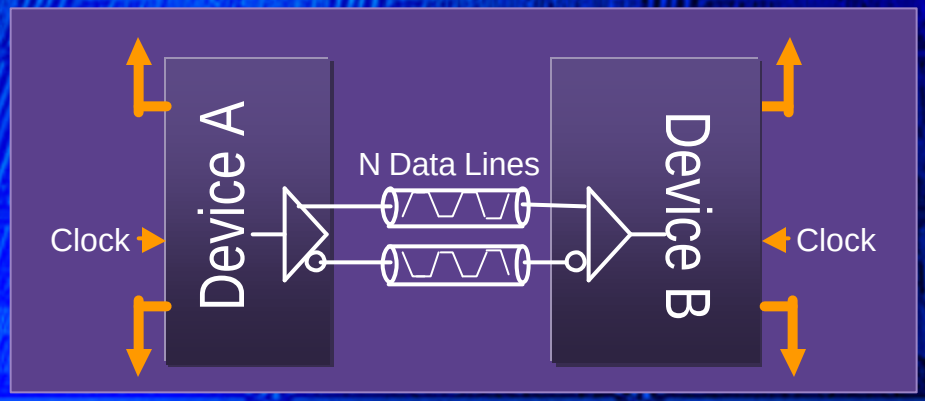
A Quantum Jump in I/O Pin Bandwidth

Typical Parallel Bus



- Multiple, parallel data lines
- Independent clock line
- High voltage, single-ended
- Bi-directional, DC-coupled
- Extra sideband signals
- BW/pin: 12.6 Mbps

3GIO/IBA Serial Bus



- 8b/10b clock-encoded data
- Differential, low voltage
- Unidirectional, AC-coupled
- All in-band signals
- hot insert/remove
- BW/pin: 800 Mbps

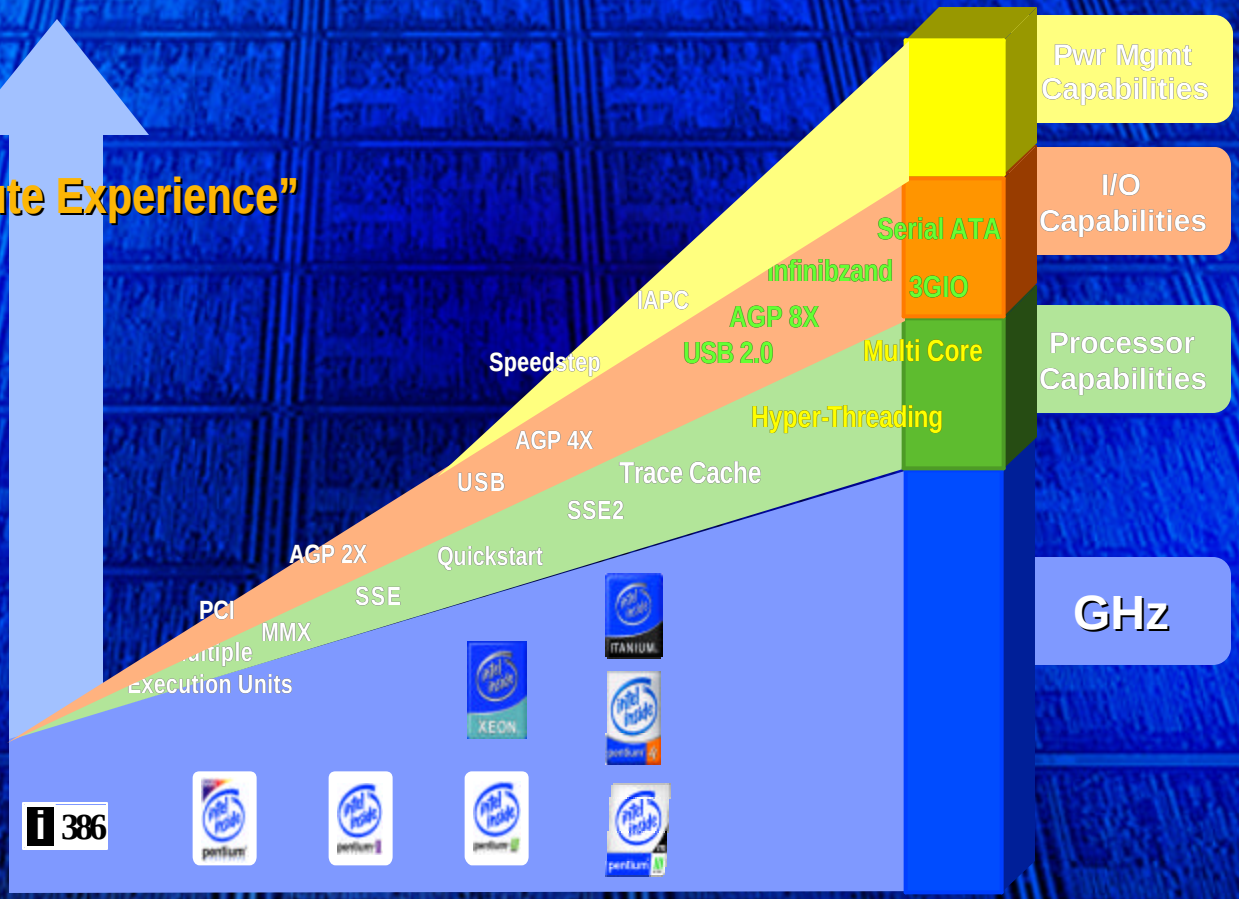
intel

3GIO Improves Pin Efficiency over PCI by > 60X

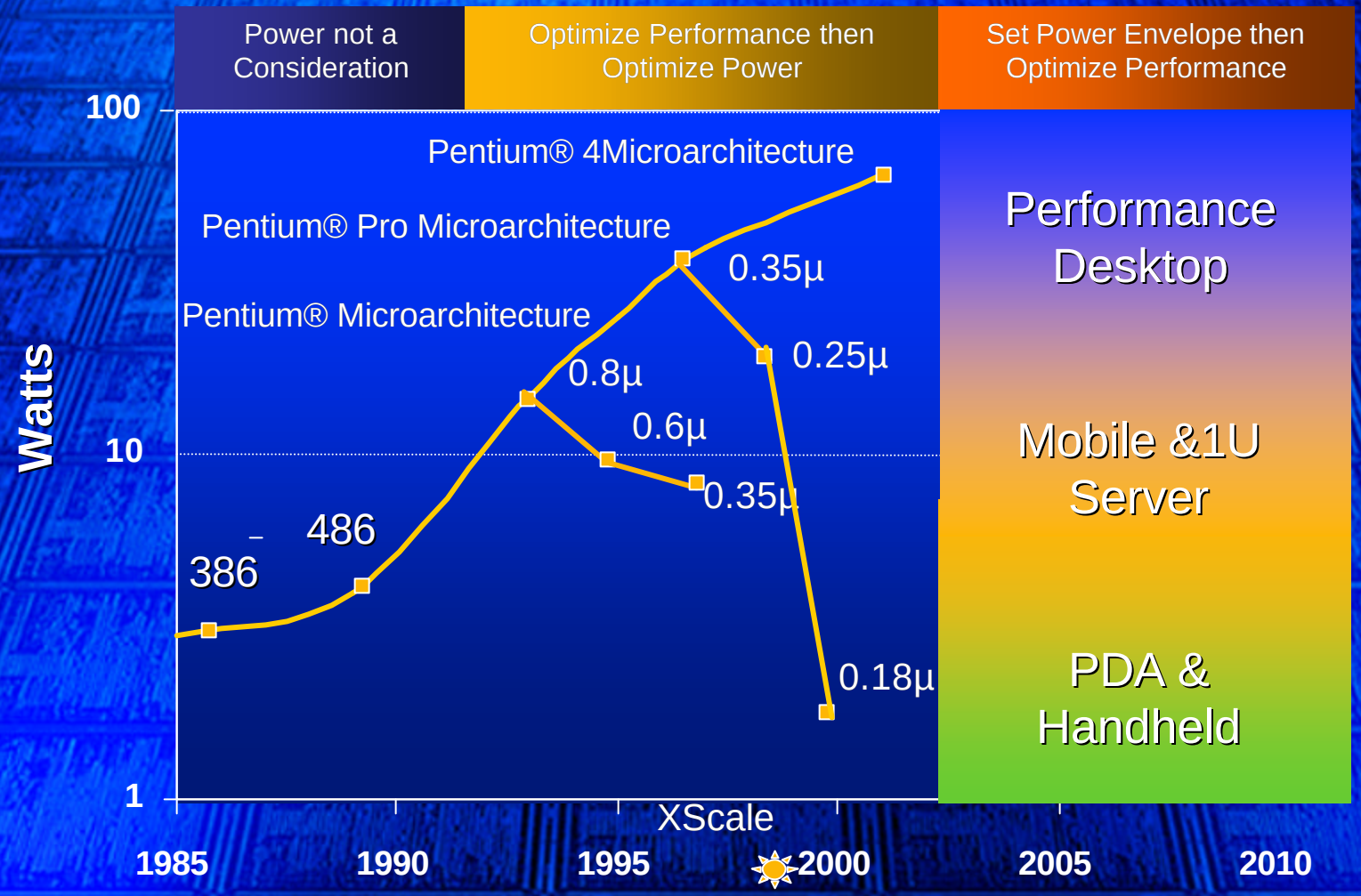
GHz: Necessary, but Not Sufficient…

Was:
How to deliver one more MHz

Is:
How to deliver a substantially better computing experience



Platforms Dictate Today's Power Limits

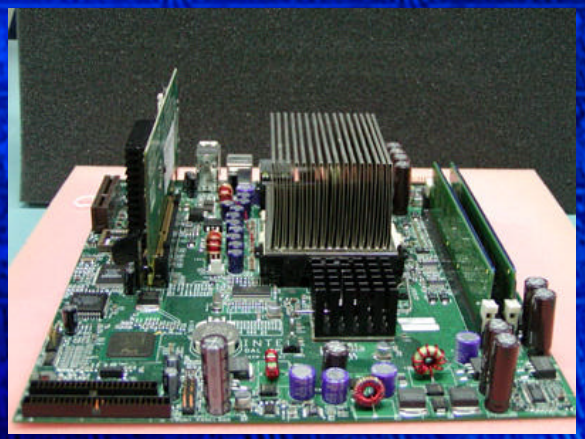


Technology scaling no longer sufficient

Shrinking Desktop Form Factors

Deep Forest: 5.9L

- 2.0 GHz Pentium® 4 Processor
- Low-profile AGP4X slot
- 7 USB Ports
- Low-profile PCI & CNR
- Cost parity with ATX



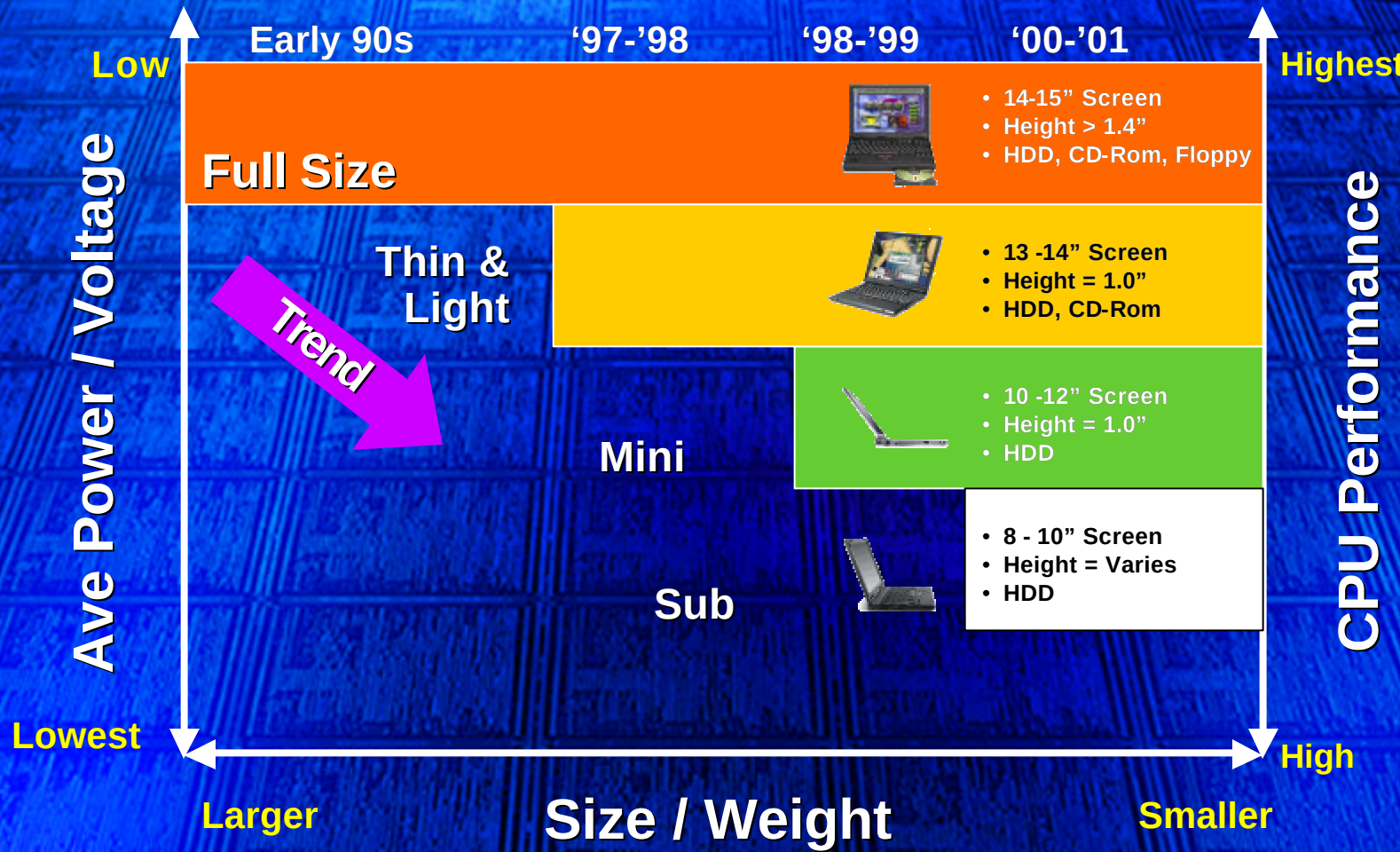
9.5”

8.5”



* Other brands and names are the property of their respective ow ners

Shrinking Mobile Form Factors

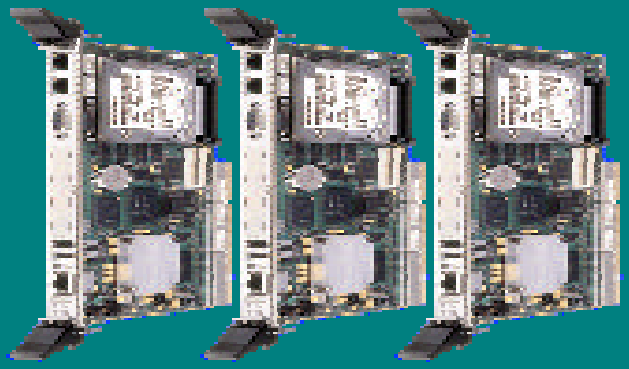


Performance *and* features, but thinner and lighter

Shrinking Server Form Factors

Data Center Front-end and Mid-tier





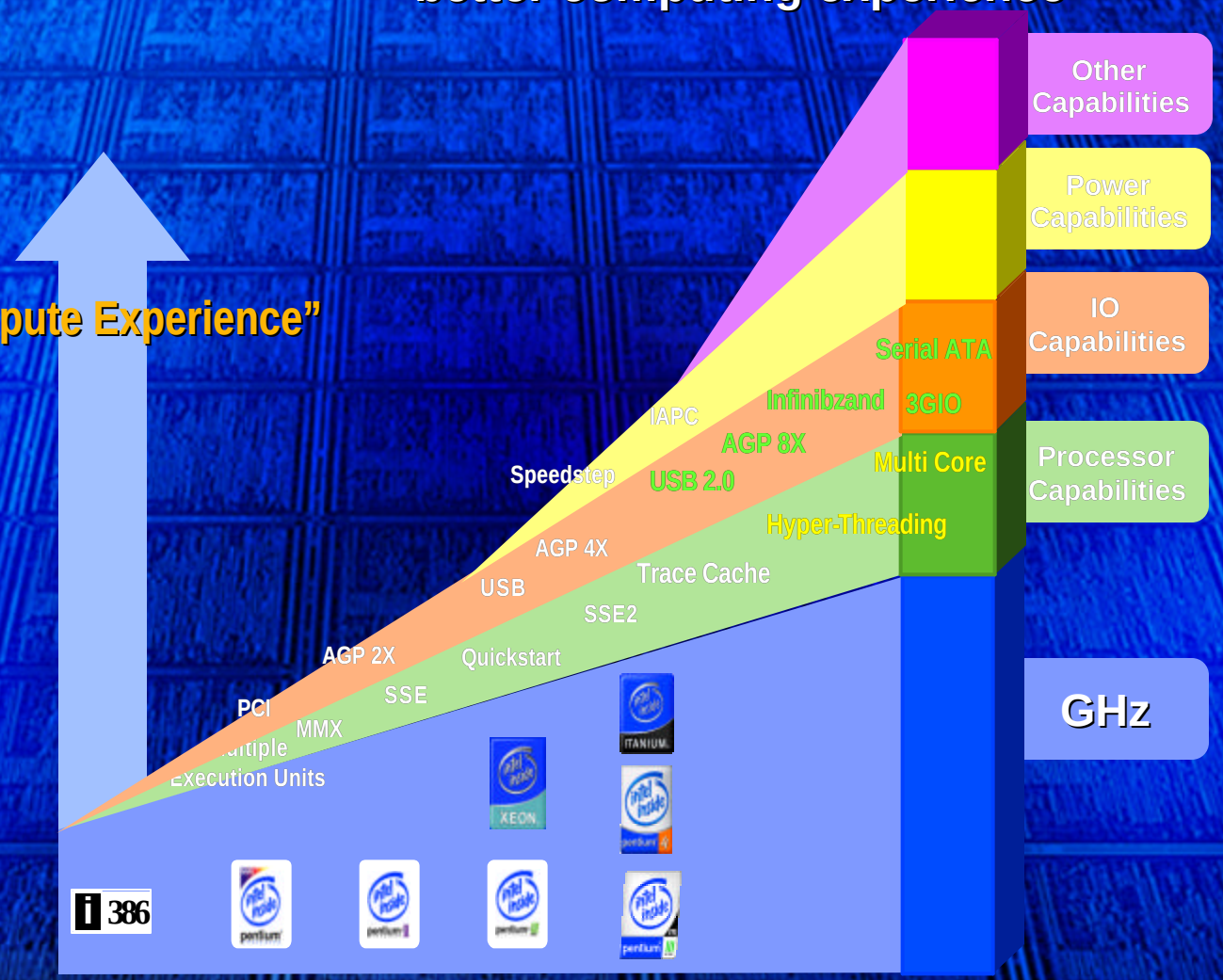
- **Data centers go high density**
 - high density, rack-mount (1U2U or blade-based)
 - storage gets out of the box (IBA & LAN/iSCSI)
- **Density has its limits**
 - Total building power and total rack power
 - Total building cooling and total rack cooling

intel

GHz: Necessary, but Not Sufficient…

Is:
How to deliver a substantially better computing experience

Was:
How to deliver one more MHz



Improving “System” Integrity



Beautifully designed

Exciting to drive when warm/dry

No crash protection

Death almost certain



Pleasant styling

All-weather performance

Extensive crash protection

Survival almost certain

intel

High Integrity Vehicles are the Norm

Improving Integrity in Desktop Platforms

Hybris displays some hubris
November 14, 2000, revised January 11, 2001

Hybris (W32.Hybris, also known as Hahaha and Snow White) is a complex supervirus whose e-mail delivery system is similar to Happy 99

Nimda hits both Windows PCs and IIS systems
September 18, 2001

Nimda is a new network-aware, mass-mailing worm …..

System Threats:

- Virus attacks
- Network attacks
- Hardware errors
- Software errors
- Compromised code
- Real-time conflicts

System Defenses:

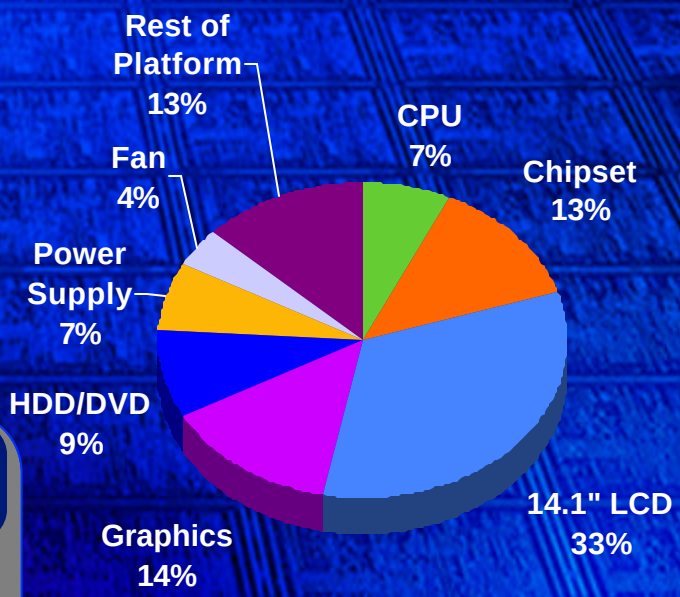
- Isolation/protection
- Attestation
- Cryptography
- Real-time resource mgmt

intel

High Integrity Computers must be the Norm

Extending Battery Life in Mobile Platforms

- It's not just the processor
- Each subsystem needs work
- Software must be power-aware



Typical Platform Power Consumption

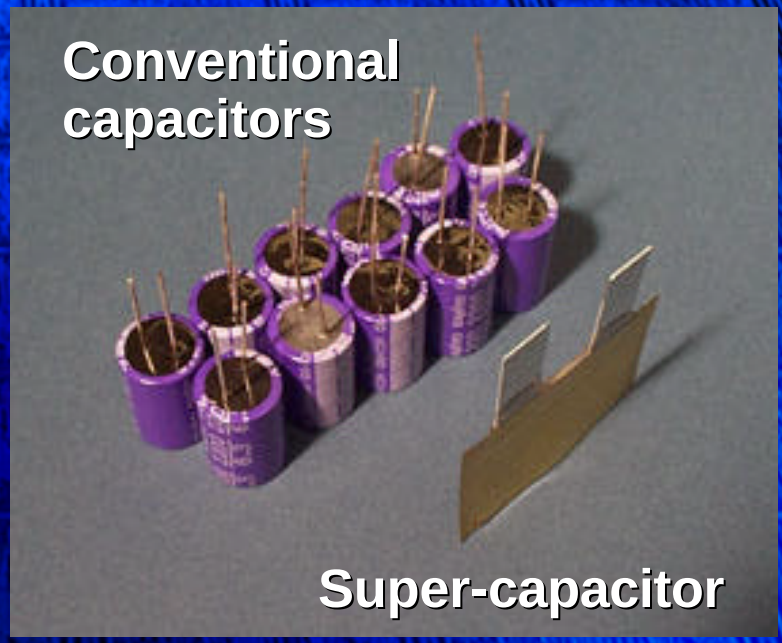
Average power consumption of an OEM T&L notebook during ZD-BL 4.01 Battery Mark

Power Delivery	Subsystem Management	Display
Improved Voltage Regulation Efficiency (CPU, HDD)	**Device** Power Performance State Management - HDD/DVD - LAN - WLAN	Improved Power Conversion Efficiency
Intel Mobile Voltage Positioning	Enhanced Speedstep Technology	Ambient Light Feedback
Super Capacitor Transient Suppression		Future Low Power Display Technology

intel

Transient Suppression with Super-Caps

- Transients causes battery voltage droop
- System suffers premature shutdown
- User is confused, angry

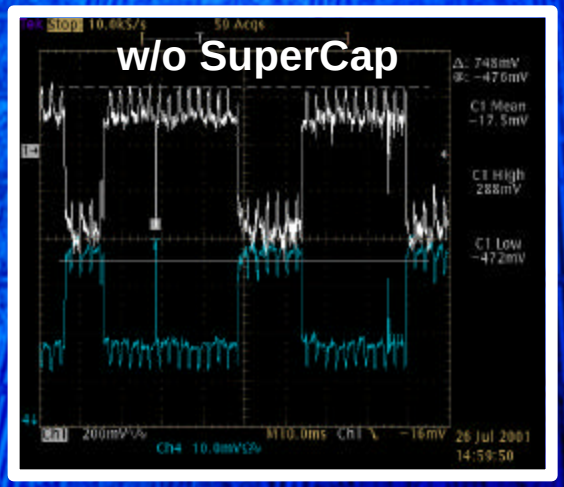


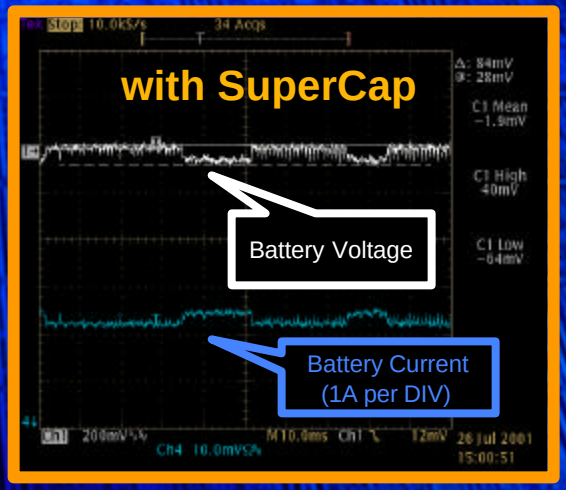
intel

Supercapacitor isolates battery from system transient

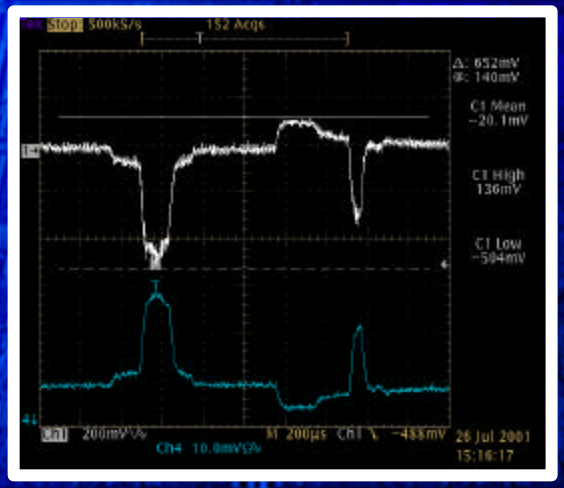
Super-Capacitor Impact at 1GHz

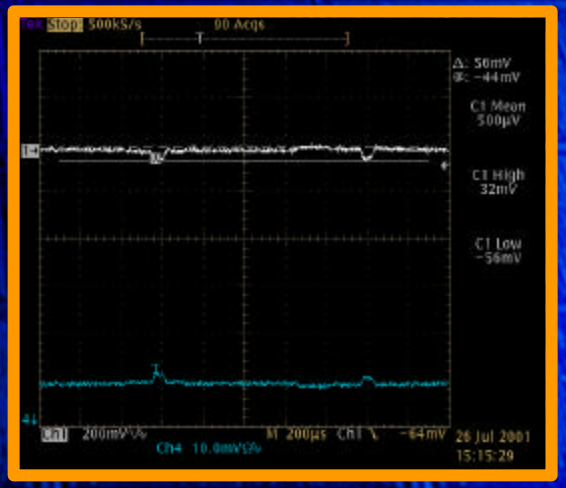
DVD App





Win-Idle

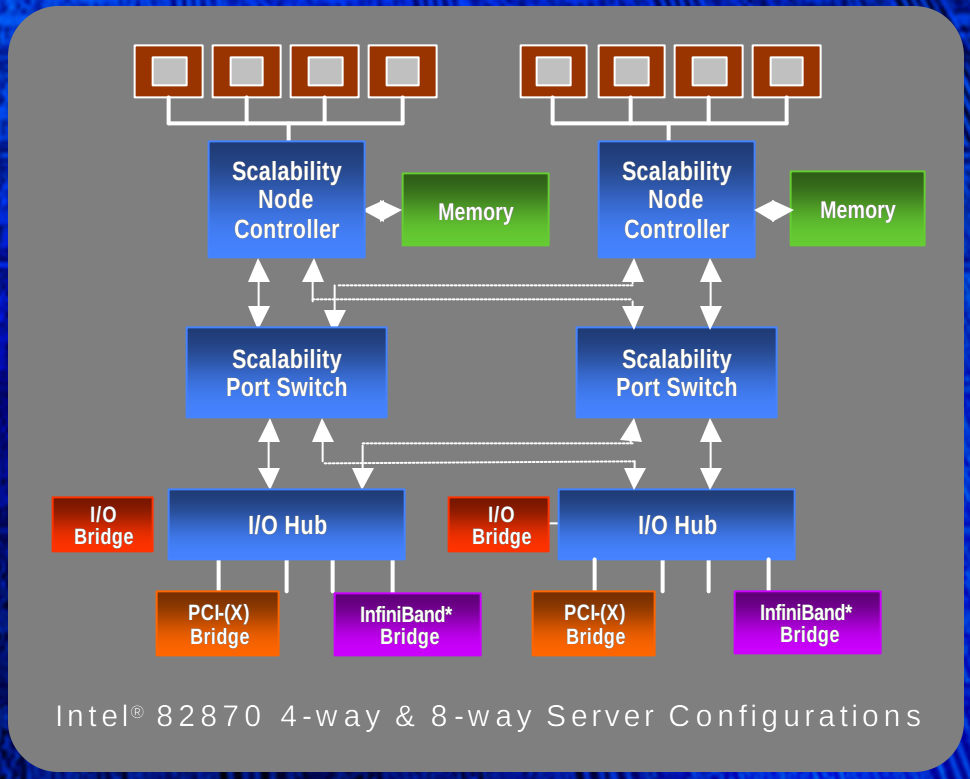




Supercapacitor extends battery life by 6%

Scalability and RAS Built-in to Next Generation Server Designs

- Highly Scalable Server Platform Architecture
 - 2 - N way systems
- RAS
 - Extensive error detection, correction and containment
 - Hot-plug via Scalability Port
- Balanced System Performance



Intel® 82870 4-way & 8-way Server Configurations

intel

Easily and Reliably add Redudancy, Concurrency and Connectivity

Summary

- GHz is necessary, but not sufficient
- Thread-level parallelism to unlock more MIPS
- High-speed serial signaling an I/O quantum jump
- Platform form factors drive power & cooling budgets
- Innovation can greatly enhance the user experience:
 - Higher system integrity and robustness
 - Improved battery life and lower weight
 - Greater scalability and enhanced RAS

